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Experimental Analyses of Thermoelectric Generator Behavior Using Two Types of Thermoelectric Modules for Marine Application

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Abstract : Thermal power technology such as the TEG (Thermo-Electric Generator) arouses significant attention worldwide for waste heat recovery. Despite the potential benefits of marine application due to the permanent heat sink from sea water, no significant studies on this application were to be found. In this study, a test rig has been designed and built to test the performance of the TEG on engine operating points. The TEG device is built from commercially available materials for the sake of possible economical application. Two types of commercial TEM (thermo electric module) have been studied separately on the test rig. The engine data were extracted from a commercial Diesel engine since it shares the same principle in terms of engine efficiency and exhaust with the marine Diesel engine. An open circuit water cooling system is used to replicate the sea water cold source. The characterization tests showed that the silicium-germanium alloys TEM proved a remarkable reliability on all engine operating points, with no significant deterioration of performance even under sever variation in the hot source conditions. The performance of the bismuth-telluride alloys was 100% better than the first type of TEM but it showed a deterioration in power generation when the air temperature exceeds 300 °C. The temperature distribution on the heat exchange surfaces revealed no useful combination of these two types of TEM with this tube length, since the surface temperature difference between both ends is no more than 10 °C. This study exposed the perspective of use of TEG technology for marine engine exhaust heat recovery. Although the results suggested non-sufficient power generation from the low cost commercial TEM used, it provides valuable information about TEG device optimization, including the design of heat exchanger and the types of thermo-electric materials.

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